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INDUSTRY 4.0 AND 5.0: STRATEGIES TO RESTORE INDIA'S MANUFACTURING SYSTEM

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ABSTRACT

India has emerged as a global economic powerhouse, ranking sixth in nominal GDP and third in Purchasing Power Parity (PPP). The Indian manufacturing system needs to be reoriented to meet the IR 4.0 and IR 5.0 standards.

The research is based on secondary data; published research papers on IR 4.0 and 5.0 from various journals, magazines, and reports from various consulting firms are gathered and reviewed to understand the research content and findings of various researchers worldwide. Data on Industry 4.0 is collected from official studies conducted by consulting firms, whilst data on policy is derived from published papers by the Indian government.

The researcher reveals that technical education and vocational training in future technologies will be critical to the success of Industry 4.0 and 5.0. Traditional education needs to be transformed, reinvented, and reoriented under the guidance of IITs and NITs to guarantee that universities become centres of excellence. When it comes to manufacturing competitiveness, India trails well behind China. The government should take precautions to avoid brain drain from the country. It should also encourage universities and IITs to do more quality research, develop application-oriented discoveries, and increase the number of patents.

KEYWORDS: Industry 4.0 and 5.0, Smart Factory, Smart Products, Global Manufacturing Competitive Index, Smart Operations, Data-driven Services.

INTRODUCTION:

In the span of three centuries (between the 17th and the 20th centuries), humans saw three industrial revolutions (IR), beginning with the steam engine in the power loom industry. Following that, electricity was created, which revolutionised society. All assembly line and industrial processes, on the other hand, remained entirely dependent on humans and labor.Technology has grown in prominence in recent years, and the discovery of computers and robotics has led to the replacement of traditional labour by robotics. Furthermore, the 3rd Industrial Revolution (Industry 3.0) was ushered in by the synchronisation of operations with computers in order to do repeated tasks without mistakes and at a faster rate.

About Industry 4.0 and 5.0:

Industry 4.0 is being used by industrial businesses in order to enhance and adapt their manufacturing processes. Digital technologies are transforming manufacturing processes in many industries, from high-tech to industrial equipment. Modern firms recognise that improving the production process for even the most basic items opens up new avenues for growth.

Industry 4.0's vision is expected to be embraced globally, and it may impact other projects and collaborative endeavours. Autonomous robots, big data, augmented reality (AR), additive manufacturing, cloud computing, cyber security, IoT, system integration, and simulation are the nine major technology components that make up the core of Industry 4.0.

Industry 4.0 aims to enable businesses to make quicker, better decisions while lowering costs and demanding fewer human inputs. It all comes down to optimising smart, flexible supply chains, factories, and distribution models in which robots collect and communicate more data to human operators and other machines through machine-to-machine interactions. The timeline below demonstrates the evolution of manufacturing.

The transition from industry 1.0 to industry 5.0 is depicted in Figure 1.

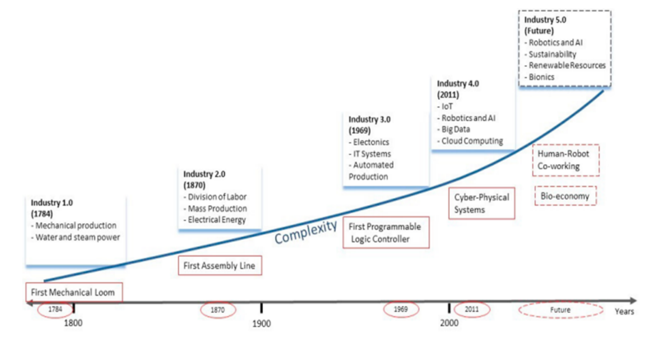

Figure 1: Industry 1.0 to 4.0 Source: Demir K.A et al (2019)

Industrial 5.0 is a development of Larry Page's notion of Industry 4.0, which he coined in 2004 as a response to the concept of Industry 4.0. It has become a subject that governments and organizations are paying attention to as a result of the pandemic's effect, the focus on topics like sustainability and resilience, and the need to put people back at the centre. Industry 5.0 is a paradigm for the next phase of industrialization, which involves the return of labor to factories, distributed manufacturing, intelligent supply chains, and hyper customization, all with the purpose of giving a personalized client experience time and time again. The distinction between industry 4.0 and industry 5.0 is explored in detail.

The focus in 5th IR (industrial revolution) is on delivery of customer experience beyond just connecting machines; hyper customization besides mass customization; responsive and distributed supply chain in addition to intelligent supply chain; interactive products in the place of just smart products and return of human resource to factories instead of distancing them from factories. The distinction between industry 4.0 and industry 5.0 is presented in table 1.

Table 1: Distinction between industry 4.0 & industry 5.0

Industry 4.0	Industry 5.0
Focus on connecting machines	Focus on delivering customer experience
Mass customization	Hyper customization
Intelligent supply chain	Responsive & distributed supply chain
Smart products	interactive products (Experience activated)
Manpower distanced from factories	Return of manpower to factories

Source: https://www.frost.com/frost-perspectives/industry-5-0

The following six dimensions can be used to assess an enterprise's preparation for Industry 4.0, according to current understanding of the concept:

Table 2: Industry 4.0: Six-dimensional assessment criteria

S. No.	Dimensions	Assessment Criteria
1	Smart Factory	Digital Modelling
		Equipment Manufacturing
		Data Usage
		IT Systems
2	Smart Product	Functionalities
		Data Analytics in Usage Phase
3	Employees	Skill Acquisition
		Employee Skill Sets

4	Strategy & Organization	Strategy
		Investments
		Innovation Management
5	Smart Operations	Cloud Usage
		IT Security
		Autonomous Processes
		Information Sharing
6	Data-driven Services	Data-driven Services
		Shares of Revenue
		Shares of Data Used

Source: AIMA-KPMG (2018) & Bhat TP (2020)

India was ranked 61 on the Network Readiness Index in 2013 based on the six-dimensional models mentioned in table 2.

Table 3: Networked Readiness Index 2016 Global Rank

Country	Rank
Singapore	1
Finland	2
Sweden	3
Norway	4
USA	5
Netherlands	6
Switzerland	7
UK	8
Luxembourg	9
Japan	10
Hong Kong	12
Korea Rep	13
Canada	14
Germany	15
Malaysia	31
China	59
Thailand	62
Sri Lanka	63
India	91
Pakistan	110
Bangla Desh	122

Source: Federation of German Industrie, The factory of the Future, 2015

In 2016, India was ranked 91st, ahead of Pakistan (110) and Bangladesh (122) but behind Sri Lanka (63), Malaysia (31) and China (59). For the second year in a row, Singapore has topped the rankings. As depicted in Table 3, the United States was ranked fifth.

Strengths of Indian economy:
The following are the advantages of the Indian economy for implementing IR 4.0 and 5.0:

i) Despite the global slump, India has emerged as a strong nation with a stable pace of GDP growth. This has attracted significant FDI and FII capital. India has ample space for expansion and growth, which makes it a rapidly growing market.

ii) India has emerged as a global economic powerhouse, ranking seventh in nominal GDP and third in terms of Purchasing Power Parity (PPP). As a result of its strong economic expansion, the country has become a global economic powerhouse. Indian economy now has a place among the G20 countries.

iii) India has emerged as the world's fastest-growing economy in the years 2016–17 with a growth rate of 7.1% in GDP, second only to the People's Republic of China.

iv) India's human capital is youthful. This indicates that India boasts the highest proportion of young people. The youthful population is not only driven but also talented and well-trained in order to achieve maximum growth. This has also encouraged international investment and outsourcing opportunities in the country.

v) A burgeoning working population and a growing middle class are likely to continue to be major demand generators for the growth of the economy.

vi) Government initiatives to support the sector include the GST, the establishment of the NEMMP (National Electric Mobility Mission Plan 2020), and FAME (Faster Adoption and Manufacturing of Hybrid Land Electric Vehicles).

vii) There is a large supply of skilled and semi-skilled human resources available, as well as a strong academic system.

viii) Even in the rural agri-sector, disposable income is expanding, resulting in increased demand for products and services, which has a substantial and positive impact on industrial production demand.

ix) With a growth rate of 20.8 percent, India has the world's 12th highest number of high-net-worth people, the most among the top 12 countries.

Industry 4.0 is critical for India's development:
The following are the points for India needs to adopt Industry 4.0:

a) Advanced analytics might aid in increasing manufacturing capacity while also improving quality. Through data analytics, the model would transition to fault prediction and prevention.

b) Robotics and automation adoption would shorten the manufacturing cycle, cut time-to-market, and result in wasteful resource utilization.

c) The digitization of many company operations would result in cost savings as well as a better customer and employee experience.

d) IoT and machine-to-machine and machine-to-machine communication would tighten supply chains and shorten lead times.

Conclusion:
Industry 4.0 intends to help organisations make better choices faster while reducing costs and requiring fewer human inputs. The return of labour to factories, dispersed manufacturing, a responsive and distributed supply chain, and hyper customisation are all part of Industry 5.0, a paradigm for the next phase of industrialisation. Beyond just relating equipment, the focus of the fifth industrial revolution is on providing a positive consumer experience. India has emerged as a worldwide economic powerhouse, ranking seventh in nominal GDP and third in terms of purchasing power parity (PPP). In 2016, India was ranked 91st out of 139 nations, ahead of Pakistan (110) and Bangladesh (122) but behind Sri Lanka (63), Malaysia (31) and China (59), implying that there is a need to orient India's manufacturing system to meet the requirements of IR 4.0 and 5.0 in order to reap the benefits of economic growth by capitalising on the strengths of the Indian economy.

REVIEW OF LITERATURE:
In particular, Jovane F et al. (2008) stated that there has been a growing consensus on the need for sustainable development (SD) and its implementation in recent years. Competitive Sustainable Manufacturing (CSM) has been widely regarded as a key enabler because of its high added value, knowledge-based nature, and competitiveness. This research paper outlines the actions that must be taken to transition from economic growth to long-term development. To create and execute CSM at the national and global levels, the Reference Model for Proactive Action (RMfPA) is recommended.

Rosen, M. A., and H. A. Kishawy (2012) said that the relevance of combining sustainability with production and design, as well as other goals such as function, competitiveness, profitability, and productivity, is being investigated. It emphasises the need to apply relevant methods such as design for the environment, life cycle assessment, and other ecologically sound approaches that consider the whole life cycle of a process or product. Sustainability and environmental stewardship are projected to become more significant issues in manufacturing and design in the future, influencing the primary goals for improving manufacturing processes and technology. Designers and manufacturing decision-makers that embrace a sustainable mindset and foster a sustainability culture inside their organisations are more likely to improve design and production. More thorough study and collaboration are needed to improve knowledge of sustainability in manufacturing and design, as well as to improve technology transfer and sustainability applications.

Garetti M. & Taisch M. (2012) opined that sustainability is and will be a critical problem for present and future generations. The prevailing notion that natural resources are unlimited and that the environment's regeneration potential can compensate for all human activity is no longer valid. To achieve this aim, a consistent effort will be necessary, as well as a suitable time frame. Fortunately, nature and the environment have the ability to self-regulate and will allow man to repair the harm he is bringing to the earth's mother if the will to do so is strong enough.

Gunasekaran and Spalanzani (2012) said that due to the influence of global warming, terrorism, earthquakes, hurricanes, and carbon footprint awareness, sustainable business development (SBD) in manufacturing and services (M & S) has become a major concern. Many forums and media outlets have discussed the relevance of SBD, including academic and industry publications. A framework for SBD has been developed, as well as prospective research directions, by identifying and critically assessing the extant SBD literature. At the completion of the project, a summary of the results and conclusions is given.

Davis, J. et al. (2012) opined that time, synchronisation, integrated performance measurements, and cyber-physical workforce needs are the defining technological threads. Smart Manufacturing is a response to and a driver of a fundamental corporate transition to demand-dynamic economics focused on customers, partners, and the general public. National interests and strategic imperatives can be better served by IT-enabled manufacturing and supply networks. It has the potential to reinvigorate the manufacturing sector by promoting global competitiveness and exports while also creating long-term jobs.

The globalisation of the world's economies provides a substantial challenge to local enterprises, according to Lee, J., E. Lapira, B. Bagheri, and H. Kao (2013), and is propelling the manufacturing industry to its next transition: predictive manufacturing. To compete, manufacturers must incorporate emerging technologies such as sophisticated analytics and cyber-physical system-based methodologies to increase efficiency and productivity. As a result of the strong push toward the "Internet of Things," data has become more accessible and pervasive, contributing to the big data environment. This issue necessitates the use of the proper approach and tools to convert data into useable, actionable information.

According to Lee, J., H. Kao, and S. Yang (2014), machines in an Industry 4.0 factory are now networked as a collaborative community. This type of evolution needs the employment of advanced prediction tools, which enable data to be systematically processed into information, which can then be used to explain uncertainty and make more "informed" decisions. Manufacturing and service enhancements based on cyber-physical systems are two inescapable trends and difficulties for the manufacturing industry. This study investigates the trends in manufacturing service transformation in a big data environment, as well as the readiness of smart predictive informatics solutions to manage big data and achieve transparency and productivity.

Brettel, M., N. Friederichsen, M. Keller, and Marius Rosenberg. As stated in 2014, in terms of product quality and production, the German manufacturing industry must contend with rising worldwide competition. Several sectors have suffered as a result of the movement of production facilities to other nations due to high labour costs. Digital engineering of goods and industrial processes is becoming more common as information and communication technologies become more widely used. Decentralized units can change goods using modular simulation and modelling methodologies, allowing for quick product innovation.

Radziwon, A., A. Bilberg, M. Bogers, and E. Skov Madse (2014) expressed that their study examines the use of the term smart in connection to technology, with a focus on the smart factory idea in modern research. The conceptualization will not only allude to numerous smart factory ideas presented in the literature but will also connect the key aspects of this emergent manufacturing concept to standard manufacturing practice. Following that, the authors explore the limitations of prospective smart factory implementations in SMEs, as well as a future research view to further develop the idea.

Schuh G, et al. (2014) disclosed that the current industrial revolution is not being driven by the manufacturing industry. Instead, the creation of social networks and smart gadgets, together with workers' attractiveness to them, is one of its key drivers. Today, interconnectedness is pushing its way into the industrial sector. According to an Accenture poll, 82 percent of Chinese respondents said they would be "more resourceful" at work if they could choose their own hardware and software. This study explores the concept that increasing cooperation productivity is one of the major aspects of Industry 4.0. Four enablers are proposed as prerequisites for this goal, and a reference system with underlying mechanisms for facilitating collaboration productivity is presented. The framework of the reference system is defined, as are concrete techniques for increasing productivity.

Ivan Peko, Ivica Veza, and Marko Mladineo (2015) said that by fostering empirical, enterprise-level research on technical and non-technological processes as well as organisational innovation, the Croatian project strives to increase scientific understanding of the current status of the Croatian manufacturing industry. The research was conducted using Web surveys and interviews with CEOs and/or technical directors of manufacturing companies in Croatia. Based on the replies of 159 Croatian businesses, the analysis and conclusions were drawn. Croatia's average industrial maturity level is assessed to be 2.15, corresponding to the second industrial generation, or the middle of the twentieth century. According to this study, less than 30% of businesses are in Industry 3.0. The primary goal of the INSENT project is to create a Croatian model of Innovative Smart Enterprise (HR-ISE model).

Hermann M, Pentek. T, and Otto B. (2016) reported that the Internet of Everything has laid the groundwork for Industry 4.0, the next industrial revolution. Despite this, there is no universally agreed definition of the word. As a result, scholarly discussion of the subject is challenging. An example of how the established design principles can aid practitioners in creating Industry 4.0 situations is shown in a case study. Furthermore, this paper defines Industry 4.0 and presents six design principles that may be used to discover prospective use cases and give assistance throughout implementation. The practical contributions of the study are twofold: First, the definition clarifies practitioners' basic understanding of the phrase "Industry 4.0"; second, it provides assistance to businesses on how to apply such a framework in their organisations.

According to Angioletti, C. M. et al. (2016), "Additive Manufacturing (AM) is recognised as one of the most effective technologies capable of producing acceptable industry-side market reactions." There is widespread agreement that manufacturing from linear to circular systems may save both biological and technical resources. Layered manufacturing has the ability to produce major changes in both economics and society, as well as to bridge the gap between the two, allowing effective circular economies to be implemented. The key environmental benefits of adopting additive manufacturing technologies in industrial production include decreased energy consumption throughout the manufacturing process, ease of decommissioning and disposal of objects, less waste, and an increased raw material recycling rate. Future studies will concentrate on the creation of procedures and quantitative models to examine how additive manufacturing technologies encourage the reuse of materials, tools, and equipment.

According to De Man, J. C., and J. O. Strandhagen (2017), sustainable business models exist in an Industry 4.0 environment that is digitising and automating, but they are not widely used. Sustainability requires not just greater efficiency, but also the use of fewer raw materials and enhanced product recycling. This paper investigates potential sustainable business situations and offers a research agenda for creating such a model. Industry 4.0 has the ability to encourage sustainable business models while simultaneously limiting them by expanding the possibilities of neoclassical corporate paradigms. In a future where obsolescence is intended, the authors of this paper describe scenarios in which service-based business models coexist with traditional company models. Whether or if Industry 4. 0 is effective in supporting sustainable value propositions will decide whether or not a market transition to sustainable products occurs.

According to Bonvoisin, J., R. Stark, and G. Seliger (2017), industrial research has devoted a lot of attention to sustainability during the last several decades. The purpose of this chapter is to provide an overview of the vast field of sustainable manufacturing research, with a focus on manufacturing technology and management. Its purpose is to describe the role of manufacturing in sustainability, identify the complementary methodologies necessary for a transition to sustainable manufacturing, and emphasise the importance of interdisciplinary research.

Bakkari, M., and A. Khatory. (2017) observed that the interconnectedness of machines, goods, and people are at the heart of Industry 4.0. This industrial revolution also reflects a desire to address contemporary concerns relating to sustainable development concepts such as resource management and energy. The purpose of this paper is to underline the relevance of the industrial countries' strategic vision for Horizon 2030, as well as the link between industry 4.0 and sustainable development.

Kiel, D., J. Muller, C. Arnold, and Kai-Ingo Voigt (2017) think that the Industrial Internet of Things (IIoT) will have a wide range of implications for manufacturers in terms of economic, ecological, and social issues in terms of the Triple Bottom Line (TBL) of sustainable value generation. The authors show that the IIoT necessitates a multidimensional expansion of the traditional TBL, including technological integration, data and information, and public context.

Prause, G., and S. Atari (2017) said that the goal of "Industry 4.0" is to create cyber-physical systems (CPS) and dynamic production networks in order to produce flexible and open value chains in the creation of sophisticated mass-customisation goods. Modular and fractal techniques, as well as network orientation, adaptability, and reactivity, are all included in current production models. The study is experimentally confirmed through the use of data samples from a business reengineering effort at a globally functioning high-tech manufacturing organisation in Estonia.

Some researchers (Miranda J. et al. 2017) are of the view that traditional product development processes may no longer be viable because they lack social aspects that enable interaction with consumers and other goods. The phrase "social communication" PCPP (Product-Consumer and Product-Product) refers to a component of product design methodology that allows for the definition of social features as major aspects of the product design process. Furthermore, for a social communications PCPP, a conceptual technique for smart thermostats is provided to show how this idea may be realised by utilising the sensing, smart, and sustainable (S3) aspects.

Müller, J. M., D. Kiel, and Kai-Ingo Voigt. (2018) stated that their study investigates the significance of Industrial 4.0-related possibilities and constraints as drivers for its implementation in the context of sustainability, with a diverse view-

point on varying business sizes, industry sectors, and the firm's role as an Industry 5.0 supplier or user. The findings indicate that strategic, operational, environmental, and social possibilities are favourable drivers of its implementation, but barriers to competitiveness and future viability hamper its advancement.

Kusiak, A. (2018) stated that the genesis, current state, and future advances in manufacturing are discussed in this study. Smart manufacturing is a new type of manufacturing that combines today's and tomorrow's industrial assets with sensors, computer platforms, control, simulation, data-intensive modelling, and predictive engineering. These ideas and technologies, if put into practice, will make smart manufacturing the hallmark of the next industrial revolution. Smart manufacturing is about autonomy, evolution, simulation, and optimization, not about the level of automation on the factory floor. The degree to which the physical company has been replicated in cyberspace will define the amount of smartness' of a manufacturing enterprise. Its essence was embodied in six pillars that set it apart from traditional manufacturing.

Industrial output, according to Beier, G., S. Niehoff, and B. Xue (2018), is critical to establishing a green economy and sustainable development goals. This article looks at how the Internet of Things may help with sustainable development's environmental concerns. It provides an up-to-date review of the literature on the industrial internet of things (IIOT)-enabled approaches for solving the three environmental issues. Because of its robust manufacturing sector and ambitious industrial digitalization aspirations, China was chosen as a case study.

Ghobakhloo M (2019) stated that the goal of this research is to identify and analyse the elements that influence smart manufacturing's application of information and digital technologies (IDT). It conducted a state-of-the-art and content-driven literature study, consulted a panel of academic and industrial professionals, and used an interpretative structural modelling approach. The findings are likely to help academics, industry leaders, and policymakers get a better understanding of smart manufacturing transformation processes and the circumstances that enable manufacturing digitalization in the industry 4.0 era.

Carla GM, Peter MW & Elias Hans DRDS (2019) have done a systematic review intended to determine how sustainable manufacturing research contributes to the development of the industry 4.0 agenda, as well as to get a better understanding of the two. It maps and summarises existing research activities, outlines research goals, and highlights research gaps and possibilities. The present research is linked with the aims specified by several national industrial programs, according to the findings, although there are still prospects for field growth.

The model-based approach proposed by Gangoiti, U et al. (2021) intends to help in the design and development of flexible production systems. The framework, according to the industry 4.0 paradigm, comprises a set of tools that automate the generation of control code extensions that add flexibility to the automated production system, based on models. This study focuses on versatile applications that employ Programmable Logic Controllers (PLCs) as principal controllers. The suggested system defines FAPS as a set of linked Controller and Plant I4.0 components that allow for QoS-based reconfiguration. A MAS-based middleware is supposed to provide QoS control in real-time, but it also provides model-based support for expressing desired system flexibility needs. By offering tools for describing critical production situations and storing this data in a model, a model editor aids designers in the building of automated production systems.

Rakic S, Pavlovic M & Marjanovic U (2021) researched and revealed that manufacturing firms in Serbia must find a way to respond to constantly changing client needs and fierce competition. The goal of this research paper is to use Industry 4.0 evaluation methodology and social network analysis to determine the level of manufacturing preparedness in Serbia. The findings of this study reveal that wireless human-machine communication technologies sparked Serbian manufacturing's digital transition from non-user to basic preparedness.

Sony, M & Aithal, P. S. (2020) stated that in both academic and industrial circles, "Industry 4.0" has become a buzzword. Because big initial expenditures are necessary, it is gradually establishing itself in impoverished countries. The Indian Engineering Industries sector is the country's largest and top earner of foreign currency. This endeavour, according to the report, will help the country strategically and aid in the acquisition of new markets.

Industry 4.0 – Readiness of Industries:
Geissbauer, R., J. Vedso, and S. Schrauf (2016) stated that "Industry 4.0" refers to the fourth industrial revolution. While Industry 3.0 was concerned with the automation of specific machines and processes, Industry 4.0 is concerned with the end-to-end digitalization of all physical assets and their integration into digital ecosystems with value chain partners. Product digitization covers the extension of current goods, such as the addition of smart sensors or communication devices that may be used with data analytics tools.

Basl and Kopp (2017) observed that smart factories and smart products are important for future industrial growth. According to their research results, some Czech industrial companies are already active in IR 4.0. The survey, however, determined that their number is insufficient in light of the Czech Republic's current state of the sector. This is most likely owing to the heavy initial investment required for IR 4.0. Government incentives or subsidies are likely to pique the interest of companies involved in the IR 4.0 trend. The majority of companies that have not yet assessed IR 4.0 stated that it is not a priority for them at this time. This might be owing to these companies' lack of knowledge about the benefits and hazards of implementing IR 4.0.

Basl Josef (2017) investigated that Czech companies have a quite high awareness of the existence of a trend known as Industry 4.0, but most employees are not yet aware of what this new trend means, according to an investigation carried out by the Czech Chamber of Commerce and Industry. Only about 8% of companies reported that their employees are already motivated by the concept - and 56% said their employees don't know what it means.

According to Samaranayake, P., Ramanathan, K., and Laosirihongthong, T. (2017), this study investigates the relative value of important enabling variables for implementing Industry 4.0 from a technical readiness stance. According to the research, process-related goals are more important than economic and environmental goals. Human knowledge of technology and how to use it are the most important components for achieving all objective objectives. By utilising the connection between process-related objectives and significant technological factors, practitioners may build appropriate strategies and policies.

Botha AP (2018) said that future-readiness levels are determined by technology, behavior, event, and future thinking capacity levels. The future-readiness index (FRI) is calculated using the complete awareness of alternative space (technology, behavior, events, and capability to do future thinking). Once the future readiness levels (FRL) and future-readiness index (FRI) are determined, it will be evident what strategic initiatives are necessary to flourish in the desired future.

According to Batchkova I. A. et al. (2018), the industry 4.0 project poses tremendous problems for governments, enterprises, and the global society as a consequence of the digital transformation and new intelligent technologies it provides in all industries. This entails creating and implementing a national plan for Industry 4.0 adoption. In this context, it is critical to analyse each country's readiness for transformation and change in light of Industry 4.0. The primary goal of the research is to describe, analyse, and evaluate some of the most promising existing methodologies for evaluating national Industry 4.0 readiness. Some of the outcomes are displayed and contrasted.

Sony Michael & Subhash Naik. (2018) said that this is the first comprehensive literature study to determine the essential components for measuring firms' preparedness for Industry 4.0. For the final thematic analysis, 68 articles were examined, yielding six main themes of preparedness factors. The interrelationship mechanism between these components was discovered, and 17 study hypotheses were developed. This article will assist firms in identifying what they need to critically assess before deploying Industry 5.0 in a company.

Hamidi, S.R. et al (2018) are confident in their study because it examines the industrial revolution that led to the current Industry 4.0 via digital transformation. The study's goal is to better understand the preparedness of Malaysia's small and medium enterprises (SMEs). The research findings will be able to explain and offer a better picture of where Malaysian SMEs are in relation to the maturity level that is set to assess their readiness.

According to Maisiri W. and L. van Dyk (2019), the adoption of Industry 4.0, the initiative driving the fourth industrial revolution, is advancing at an exponential rate and is unavoidable for survival and competitiveness. The Impulse Foundation of the Verband Deutscher Maschinen- und Anlagenbau (VDAAN) developed a questionnaire instrument with quantitative criteria for this study. It was determined that the South African industry has significant challenges in developing strategies and constructing equipment infrastructures to meet Industry 4.0 standards. More study is needed to understand more about the industry 4.0 competencies that South African firms and sectors require.

Leadership, according to Valeria E Guzmán et al (2020), is necessary to successfully develop an innovation culture in firms. As a result, leaders play a vital role in the shift to Industry 4.0. The goal of this research is to give important leadership characteristics and skills in the context of Industry 4.0. The majority of it was based on a review of the literature on leadership and Industry 4.0. This study identified 10 leadership attributes for industry 4.0 and their associations with four kinds of leadership talents: cognitive skills, interpersonal skills, business skills, and strategic skills. Organizations may consider these skills to be necessary for leaders in the IR 4.0 shift.

For each Industrial Revolution, R. Kelly (2018) depicts leadership periods during the different Industry Revolutions (IR). For the first IR, charismatic leadership refers to how a leader acts and galvanizes a group by their actions and personal characteristics. The second IR was heavily influenced by scientific management, in which executives adopt a top-down leadership style that may be described as the directive. The third IR is about relational leadership which is defined by the consideration of transformational leadership theories to inspire the autonomy of followers for new ideas and collaboration among them. Transactional leadership, which is more performed and acknowledged by the

accomplishments of followers' aims, is also a feature of the third IR. According to the scenario, the fourth IR demands leadership to have both current and new necessary attributes.

Based on interviews with successful leaders of major enterprises, start-ups, and non-profit organisations to learn about what it takes to become a leader, Ashkenas R & Manville B identified six leadership competencies. According to their research, these skills include: 1) shaping a vision to focus and challenge the team; 2) translating the vision into a clear strategy about what actions to take and what not to take; 3) recruiting, developing, and rewarding a great team; 4) focusing on measurable results; 5) promoting innovation and learning to sustain the team or organisation, and 6) leading him or herself. According to the authors, the important criteria for developing competency in these leader abilities are based on continuous practise and genuine or real experience rather than merely reading and learning from books or theoretical knowledge. Further, the researchers emphatically say that reading books and attending training classes are not the only ways to improve leadership skills; one must also get real-world practise and experience. Building a cohesive vision, formulating strategy, hiring and motivating the right people, focusing on performance, innovation, and leading themselves are six areas of action that are particularly important for growing leaders.

Sony Michael & Aithal P. S. (2020) reveal that Indian Engineering Industries are one of the largest divisions of Indian Industries, and the implementation of Industry 4.0 will turn them into global market competitors. But before an organisation begins to implement, it must do a specific evaluation to determine how effective the implementation will be in the organisation. This paper presents a methodology for conducting such an evaluation that is multidimensional and will assist companies in predicting their performance.

Leos Safar et al. (2020) observed that Industry 4.0 concepts, frameworks, and technologies are becoming increasingly important in order for industrial firms and small and medium-sized businesses (SMEs) to acquire sustainable and competitive advantages. Research findings demonstrated a low degree of knowledge of the I4.0 concept and its components, which leads to insufficient future actions and expectations. According to the survey, respondents who had prior knowledge of the framework had more favourable attitudes and predictions for future developments.

Ishita A & Neeraj S (2020) revealed that integration of Industry 4.0 with production technologies and processes ushers in a new technological era that will further revolutionize industry and production value chains. The study backs up the notion that the pharmaceutical manufacturing business would be able to offer high-quality, personalized products at a fair cost. However, this requires more immediate attention than normal, and unless the level of preparation of the leadership team, infrastructure, and general staff in pharmaceutical production units is assessed, we are sure to miss the bus.

Alessia M.R. Tortora, et al (2021) revealed that Few studies exist that provide precise information on how manufacturing organisations, particularly those in smaller industrial settings, are dealing with the digital revolution. More than half of those polled had either a rudimentary understanding of enabling technology or none at all. MSMEs are unsure about the financial and technical requirements, as well as the overall impact, of implementing I 4.0.

REVIEW SUMMARY:

Industry 4.0 is concerned with the digitization of all physical assets from beginning to finish. The majority of employees are unaware of the implications of this new trend. The industrial internet of things (IIoT) entails a multi-dimensional extension of the triple bottom line, which includes technical integration, data and information, and public context. Smart factories, smart goods, employee adoption, strategy and organisation, smart operations, and data-driven services were the six pillars that set it apart from traditional manufacturing. Most organisations are unaware of the potential benefits of Industry 4.0 technologies; they must first have a comprehensive grasp of the many components and build the requisite knowledge, skills, and confidence.

Several firms that haven't examined IR 4.0 believe it's not a focus right now. This could be due to a lack of awareness among these firms about the benefits and risks of embracing IR 4.0. Malaysian SMEs are apprehensive about the financial and technological requirements, as well as the overall implications of implementing IR 4.0. In Croatia, the average degree of industrial maturity is 2.15, corresponding to the second industrial revolution, or the mid-twentieth century. More research is needed to better comprehend the capabilities of Industry 4.0 that South African businesses and sectors demand. Government incentives or subsidies are likely to attract businesses in the IR 4.0 movement.

To get a deeper understanding of sustainability in manufacturing and design, as well as to increase technology transfer and sustainability applications, more in-depth research and cooperation are required. Because of its high added value, knowledge-based nature, and competitiveness, Competitive Sustainable Manufacturing (CSM) has been generally acknowledged as a major enabler. Transitioning from economic growth to long-term development requires certain activities. The Reference Model for Proactive Action (RMfPA) is suggested for developing and implementing CSM at the national and global levels.

Cognitive, interpersonal, commercial, and strategic leadership abilities are investigated in connection to four sets of leadership talents. This book exposes what it takes to be a successful leader based on interviews with outstanding leaders of huge corporations, start-ups, and non-profit organisations. In the shift to Industry 4.0, leaders are crucial. Other researchers have identified six leadership skills that have been identified by other researchers: creating a vision to motivate and challenge the team; translating the vision into a plan; recruiting, developing, and rewarding a great team; focusing on quantifiable outcomes; encouraging innovation and learning to keep the team or organisation afloat; and leadership. Experts say that reading books and attending training sessions aren't the only approaches to building leadership abilities.

RESEARCH GAPS/QUESTIONS:

Based on the literature review, the following research questions might be considered:

i) What is the current state of India's manufacturing industry?

ii) What are the industry's strengths? Is it capable of implementing IR 4.0?

iii) What are the government of India's attempts to encourage and grow the sector so that it can implement IR 4.0?

iv) How does India rank in the Global Manufacturing Risk Index for 2021, as well as in prior years?

v) Does India have enough trained workers to embrace IR4.0?

vi) Are SMEs familiar with IR 4.0 and its components? Do they think IR4.0 is a good idea? What do they think about IR4.0 and its components?

vii) Is India Inc's management in support of IR 4.0? Do they have the necessary leadership to implement IR 4.0?

SIGNIFICANCE OF THE RESEARCH:

The terms "Industry 4.0" and "Industry 5.0" are not well-known. The management and staff of SMEs are unaware of the principles' relevance. Through this research piece, the teaching and learning community will learn about the concept of IR 4.0 and 5.0, its advantages, and the need to go forward in terms of economic and technological advancements for the welfare of society. This study provides a thorough overview of the literature, allowing industry professionals to conduct empirical research and analyse the adoption of IR 4.0, as well as its cost-benefit analysis, in order to make an informed decision regarding its adoption.

OBJECTIVES OF THE RESEARCH:

The objectives of the research are stated as follows:

a) Research the current state of India's manufacturing industry in terms of its ability to implement Industry 4.0.

b) To learn about any government of India efforts aimed at promoting and developing the manufacturing industry in India so that it can adopt IR 4.0.

c) To identify areas where IR 4.0 adoption is lagging or posing issues.

d) To provide a complete paradigm for strategizing in the context of IR 4.0 and 5.0.

METHODLOGY:

The research is based on secondary data; published research papers on IR 4.0 and 5.0 from various journals, magazines, and reports from various consulting companies are gathered and examined to understand the research content and outcomes of various researchers across the world. Data on industry 4.0 is derived from public studies by consulting companies, while policy-related data is derived from published reports by the Indian government. As a result, the retrieved data is categorised and tabulated in accordance with the study goals. The source's credibility is indicated for each table in the research paper. The percentages and rankings are employed to portray the data for the research paper. Furthermore, pictorial representation is used to provide better clarity of the data to understand the situation without any confusion.

RESEARCH RESULTS:

The research results are presented as follows:

a) Current status of Industry 4.0 in India:

AIMA-KPMG (2018) reported that by 2023, the global (Industry 4.0) I4.0 market is anticipated to reach INR 13,90,647 crore. I4.0 has been adopted by countries such as the United States, China, and Japan, as well as European nations such as the United Kingdom, Ireland, Sweden, and Austria.

India is the sixth-largest manufacturer in the world. As a result, manufacturing is seen as a critical component of the country's long-term goal. The government has emphasized the 'Make in India' programme as a means of achieving this goal. The government announced a new policy in July 2017 to increase manufactur-

ing's contribution of GDP to 25% by solidifying the Make in India project, with an emphasis on the use of digital platforms for Industry 4.0.

Manufacturing is expected to account for 25% of GDP by 2022, up from its current level of 17%. The administration has enacted a variety of policies and initiatives, including as the implementation of the GST (Goods and Services Tax) and the liberalisation of the FDI policy.

b) Manufacturing – a crucial sector of India:
The automotive industry in India is one of the largest in the world, accounting for more than 7.1% of the country's GDP. In addition, it accounts for about 22% of the country's manufacturing GDP.

Table 4: India's Accomplishments at Global Level

Type of Automobile	Position
Tractor manufacturer	1
Two-wheeler manufacturer	2
Bus manufacturer	2
Heavy truck manufacturer	5
Car manufacturer	6
Commercial vehicle manufacturer	8

Source: ACMA, 2020

Foreign direct investment (FDI) was first allowed into the industry in 1991 as part of India's economic liberalization, and it has come a long way since then. In addition, the country is currently the sixth largest auto market in the world, with ambitions to become the third largest by 2020. According to the Automotive Components Manufacturers Association of India, the industry India's automotive industry is ranked first in the world (ACMA). India's accomplishments in the automobile sector depicted in table 4. Moreover, McKinsey Global Institute projected that 3D Printing annual market growth will be at 19.6% per annum. Some of the manufacturing companies have already adopted IR 4.0, for example, ITC Ltd is implementing Industry 4.0 in packaging and logistics applications; Over 24 industries, including Nicks Auto, Hero Cycles, Vardhman Steel, Tyson India, Akzo Nobel India, and Tynor Orthotics, are utilising automation; and HMEL Bathinda received the customer excellence award in 2019 for using Robotics Process Automation.

According to Cushman & Wakefield's 2021 Global Manufacturing Risk Index, India has emerged as the world's second most sought after manufacturing destination, indicating the growing interest shown by manufacturers in India as a preferred manufacturing hub over other countries, including the United States and those in the Asia-Pacific region.

India's operational circumstances and cost competitiveness are contributing to the increased emphasis on the country. In addition, the country's demonstrated effectiveness in achieving outsourcing standards has resulted in an annual gain in the ranking.

c) Global Manufacturing Risk Index 2021:
Cushman & Wakefield Plc has published the Global Manufacturing Risk Index for 2021. Cushman and Wakefield are a multinational commercial real estate services corporation with offices all over the world.

The Global Manufacturing Risk Index compares 47 nations from Europe, the Americas, and Asia Pacific to determine which is the most advantageous/suitable/desirable destination for manufacturing investment.

Table 5. Global Manufacturing Risk Index 2021 – Selected Top Nations

Baseline	Ranking			Cost	Ranking			Risk	Ranking		
Nation	2019	2020	2021	Nation	2019	2020	2021	Nation	2019	2020	2021
China	1	1	1	China	1	1	1	China	5	5	1
India	4	3	2	Indonesia	5	5	2	Canada	2	1	2
USA	2	2	3	India	6	3	3	USA	1	2	3
Canada	5	5	4	Vietnam	4	2	4	FinLand		8	4
Czech Republic	6	4	5	Thailand	9	7	5	Czech Republic		6	5
								India		30	28

Source: https://www.cushmanwakefield.com

Manufacturing index has improved from 4th place in 2019 to 3rd place in 2020 and 2nd place in 2021. India also performed well on a cost basis, rising from sixth place in 2019 to third place in 2020 and 2021. Similarly, from a risk factor standpoint, from 30th place in 2020 to 28th place in 2021.

This implies that if China is not overcome, it is critical to preserve the second place (baseline rating). However, there is a tremendous need to work hard on improving cost effectiveness and lowering risk levels.

d) Smart Factory:
Bengaluru is home to India's first smart factory, which will transition from automation to autonomy and allow machines to communicate with one another. The Boeing Company has invested in the Indian Institute of Science's (IISc) Centre for Product Design and Manufacturing (CPDM), which is making good progress. The future is a smart factory, equipped with data interchange in production and the Internet of Things (IoT), which experts refer to as Industry 4.0. According to reports, the smart manufacturing business will be worth $215 billion by 2025, and it will be accepted by all major economies. For Industry 4.0, a Centre of Excellence (CoE) on IT has been established. This CoE would serve as a resource group for entrepreneurs and start-ups, spreading the notion of information technology and its implementation in I4.0.

e) Green Energy Corridors:
Green Energy Corridors have been constructed by the Indian government to enhance the usage of renewable energy and to build smart networks to accommodate variable renewable energy input. Andhra Pradesh, Rajasthan, Tamil Nadu, Gujarat, and Himachal Pradesh are among the states that have begun work on this project, which has cost India over $1 billion.

f) Internet of Thing:
One of the most decisive elements of Industry 4.0 for India is the Internet of Things, which is estimated to account for more than 20% of the worldwide Internet of Things (IoT) industry in the next five years. By 2020, the worldwide market is estimated to reach $300 billion. The major states of Indi are taking serious steps to adapt to Industry 4.0. Andhra Pradesh has taken steps to leverage on the country's IoT potential. The state administration has passed a first-of-its-kind IoT strategy, with the goal of transforming the state into an IoT centre by 2020 and capturing up to 10% of the country's market share.60 percent of the Indian IoT market is held by the industrial IoT and 28 percent CAGR growth expected for IoT market in India INR 36391 crore in 2018 to INR 1.05 lac crore (15 billion USD) in 2020. Indian businesses are increasing their focus and collaborating with other businesses to build innovative IoT and M2M solutions. In order to address local concerns, the Indian government's Digital India initiative is likely to place a greater emphasis on IoT.

g) Installation &Use of Robots in Manufacturing Companies:
Among Asia's rising markets, India is among the fastest expanding economies. While recent worldwide results have been rather mild, India achieved an amazing growth rate of 39 percent in 2018 (IFR Press Room, 2019).

Table 6: Annual Installations of Industrial Robots - 15 Largest Markets

Nation	No. of Robots (in ,000)
China	168.4
Japan	38.7
USA	30.8
Korea	30.5
Germany	22.3
Italy	8.5
Taiwan	7.4
France	5.4
Singapore	5.3
Spain	3.4
Mexico	3.4
India	3.2
Thailand	2.9
Canada	2.6
UK	2.2

Source: World Robotics Report 2021

For some years now, the number of robot installations has been constantly increasing. Between 2013 and 2018, India experienced a 20 percent compound annual growth rate. Market for smart devices will be more than 2 billion by 2020.

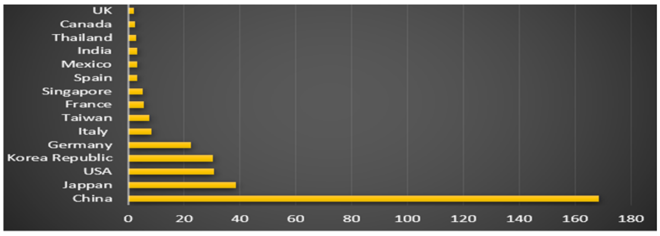

Figure 2. Annul Installations of Industrial Robots – 15 largest markets (in, 000 units)

Table 6 shows the yearly installation of industrial robots (in,000) in the top 15 markets according to the World Robotics report (2021). India is one of the 15 largest markets, with 3200 installations every year. In comparison to the others, India lags.The same situation is depicted by the figure 2. On the whole there is need of increasing the robotic culture in the industrial application.

h) Lack of Skill & Know-how:
Lack of skills to pose significant challenges for Industry 4.0 adoption in India. India has 44 lakh vocational training capacity for over 50 crore workforces. But Vocational training capacity as a percentage of total workforce is very low in our nation when compared to the other countries (Chaitanya M 2017) which is depicted in table 7and Figure 3.

India lags behind in terms of vocational training capacity as a percentage of total workforce, necessitating the establishment of new vocational training institutes and the expansion of the country's vocationally trained and skilled workforce.

Table 7: Lack of skill & Know-how

Country	Vocational training capacity as a percentage of total work-force
India	0.80%
USA	6.70%
China	11.50%

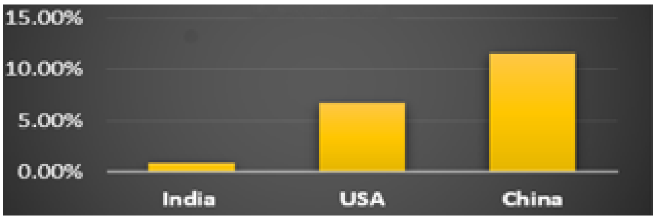

Figure 3: Vocational training capacity as a percentage of total work-force

Source: Chaitanya M (2017)

However, the Government of India has been initiated to increase the skilled work-force with the following mentioned:

- 75 percent of global digital talent is present in the nation.
- Each year, around 7,80,000 engineers are graduated in the country.
- The NASSCOM platform has been created to train 2 million technology experts as well as an additional 2 million potential employees and students.
- The presence of state-run engineering and technology institutes such as IITs, NITs, and IIITs that offer industry-related courses and degrees.

i) Formal Skilled Work-force:
In India, just 4.69 percent of the workforce is officially skilled, compared to 52 percent in the United States, 68 percent in the United Kingdom, 75 percent in Germany, 80 percent in Japan, and 96 percent in South Korea. Skilled employees make about 24 percent of the workforce in China, another growing economy (Table 8& Figure 4).

However, according to Ernst & Young, a professional services organisation, by 2026, 64 percent of India's population would be in the working age bracket of 15-59 years. By 2025, India is predicted to have the world's largest workforce with English speakers (Chaitanya M 2017). Further, at the same time, the globe is expected to confront a shortfall of 56.5 million skilled human resource by the end of the year, while India is expected to have a surplus of 47 million, according to Indian government statistics.

Table 8: Formal Skilled Work-force

Nation	Formal Skilled Work-force Percentage
India	4.7
China	24
USA	52
UK	68
Germany	75
Japan	80
S. Korea	96

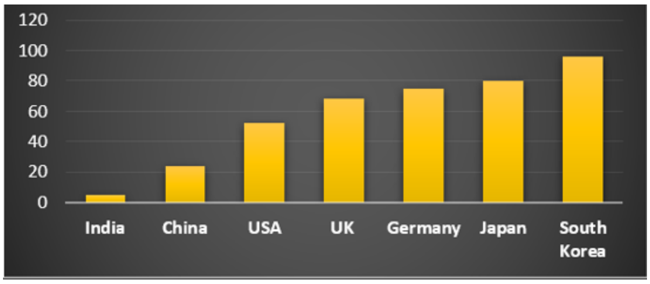

Figure 4: Formal Skilled Work-force Percentage

Source: Chaitanya M (2017)

j) Awareness of IR 4.0 & Elements:
Leos Safar et al. (2020) did a survey-based study in South India, where various industries operate in various categories, with a large presence of SMEs. The purpose of this survey is to investigate the level of understanding, awareness and general consciousness of Industry 4.0 among South Indian students, employees, entrepreneurs, and other residents. The responses to awareness are tabulated and presented in percentage in table 9 and demonstrated in Figure 5 for better clarity of the responses.

Table 9: Awareness on Industry 4.0 & Other Elements (n=564)

Response	Cloud Solutions	Mass Customization	IoT	Industry 4.0 Concept	Smart Manufacturing	Smart Cities	5G
Yes (%)	60.11	41.67	63.83	50.35	60.28	71.28	67.02
No (%)	39.89	58.33	36.17	49.65	39.72	28.72	32.98

Source: Leos Safar, et al (2020)

According to the researchers, 60 percent of respondents had never heard of mass customisation, and maybe more crucially, approximately half have never heard of Industry 4.0. In addition, almost 40% of respondents are unclear of the idea of smart manufacturing, 36% are clueless of IoT, 33% are dubious of 5G, and 29% are unaware of the concept of smart city.

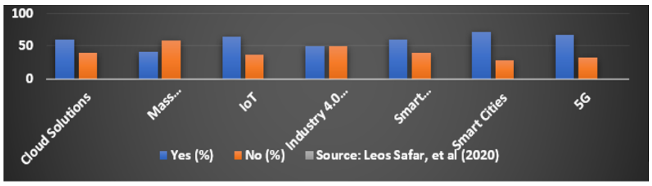

Figure 5: Awareness on Industry 4.0 & Other Elements

This implies that there is a more need of awareness programs and campaigns on IR 4.0 and its element among the stakeholders first and the general public to claim that the Indian industry and the benefits of its transformation to IR 4.0.

k) Perception on Industry 4.0:
The responses to the listed four questions on the importance of IR 4.0 are tabulated and presented in percentage in table 10 and demonstrated as per the survey of Leos Safar et al (2020).

Around 25 percent of those polled had no opinion on the four topics posed by the researchers in their study in south India, which is a major concern. Further, more than 10 percent of the respondents believe it is not at all important (for all four questions), reflecting that respondent hold a poor opinion of IR 4.0 and its components. This indicates that extensive technical seminars and workshops on IR 4.0 and its aspects are required for SMEs and technical graduates in order to educate on the benefits that the industry and enterprises may derive from the complete implementation of IR 4.0.

Table 10: Perception on Industry 4.0 (n=564)

In your opinion how important is (Response in Percentage)	IoT and IR 4.0 concept implementation?	To invest in Training their workers for new technological processes and prepare them for IoT & other innovations in Manufacturing?	To approach smart manufacturing?	E-Commerce for South India's SMEs?
Not at all Imp	17.38	11.52	10.28	12.41
Slightly Imp	14.18	14.01	14.36	14.72
No Opinion	28.19	24.11	24.11	28.9
Fairly Imp	10.64	16.13	11.88	17.2
Very Imp	29.61	34.23	39.37	26.77

Source: Leos Safar, et al (2020)

l) SMEs' Opinion on Industry 4.0:
The responses to the listed three questions on the readiness of SMEs for IR 4.0 are tabulated and presented in percentage in table 11 and demonstrated as per the survey of Leos Safar et al (2020)

Table 11: SMEs' Opinion on Industry 4.0 (n=564)

In your opinion (in Percentage)	Is IoT and IR 4.0 concept cost-effective for South Indi's SMEs?	Are South India's SMEs ready to implement IoT and IR 4.0 concept?	Is IoT and IR 4.0 concept implementation important for you personally
No	15.07	15.25	24.29
Rather No	11.17	7.45	7.62
No Opinion	32.27	33.51	21.1
Rather Yes	17.73	18.97	16.67
Yes	23.76	24.82	30.32

Source: Leos Safar, et al (2020)

A key problem is that between 21 and 33.5 percent of individuals interviewed had no opinion on the three themes raised by the researchers in their study in south India. Furthermore, 15 to 24 percent of respondents answered "no" to all three questions. For the three questions, 50 percent or more have answered 'no' or 'no opinion.' Only 40 to 46 percent of respondents rate IR 4.0 positively, while the remainder rate it negatively. Majority of the respondents had a negative assessment of IR 4.0, its components, cost projections, and SMEs' readiness for IR 4.0. This demands exact cost forecasts, financing arrangements with favourable terms, SME-focused training and workshops, and other client-based services in order to effectively persuade SMEs to embrace IR 4.0 without difficulty in order to improve the efficiency and global competitiveness of their businesses.

Challenges to India in the context of IR 4.0 and 5.0:
The following are the perceived concerns and impediments to deploying IR 4.0 in India (ISA Interchange (2022):

i) Data security threats
ii) Fear of failure and distrust
iii) Lack of resources and knowledge to scale
iv) Inadequate leadership support and attention
v) Lack of in-house data analytics expertise.
vi) Jugaad mentality from the factory floor to the managerial level.
vii) Insufficient transparency on the supplier's part can lead to a lack of confidence among investors or management over ROI.
viii) No enthusiasm for innovation
ix) Less assistance from shop-floor staff
x) Management's lack of coordination
xi) Too many stakeholders to decide.
xii) India's political situation and policies cause concern.
xiii) Unclear budget figure by the project manager

STRATEGIES:
The following are the recommended strategies for implementing IR 4.0 and 5.0 easily and effectively:

1) Human Capital Development:
It is necessary to reorganise the educational system to meet the demands of industry and business while taking evolving technologies into account. The success of IR 4.0 and 5.0 will rely heavily on technical education and vocational training in future technologies. Under the leadership of IITs and NITs, traditional education will be reformed, redesigned, and reoriented to ensure that universities become centres of excellence in the long run.

2) Strategy and Organization:
a) Leadership abilities Leadership skills are required of management and upper-level staff. According to Mumford T, Campion M, and Morgeson F (2007), talents are essential for getting things done by and through people. Table 12 shows a general classification of the talents into four areas.

Table 12: Four Groups of Leadership Skills for Industry 4.0

Cognitive Skill (CS)	Business Skills (BS)	Interpersonal Skills (IS)	Strategic Skills (SS)
CS1: speaking	BS1 operations analysis	IS1 social perceptiveness	SS1 Visioning
CS2: active listening	BS2 management of personal resources	IS2 Coordination	SS2 Systems Perception
CS3 writing	BS3 Management of financial resources	IS3 Negotiation	SS3 System Evaluation
CS4 reading comprehension	BS4 Management material resources	IS4 Persuasion	SS4 Identification of downstream consequences
CS5 active learning			SS5 Identification of key Causes
CS6 critical thinking			SS6 Problem Identification
			SS7 Solution Appraisal

Source: Mumford T, Campion M & Morgeson F (2007)

As a result, management should provide leadership training workshops for senior level managers and department heads, as well as ensure that all sectional, departmental, and senior level managers have the necessary leadership abilities.

b) Cost-effective Investment:
The company that wants to adopt IR 4.0 needs investment. The firm will generally look to mobilize cost-effective capital to invest in new technologies and human capital training. RBI and SEBI may have a constructive role to guide the firms in procuring easy and low-cost finance.

e) Innovation Management:
To avoid deviation and reduce the cost of innovation, management must relate all innovations that occur with business goals. Only when the firm's leadership has a clear vision can innovations be more effective. All employees should be given the opportunity to be creative. All employees and workers should be permitted to participate in the innovation process since participation implies a wide variety of input into the strategy. Implementation is a framework for organising and managing ideas, thus it necessitates a significant amount of effort.

3) Smart factory:
Experts in Industry 4.0 describe the future as a smart factory with data interchange in manufacturing and the Internet of Things (IoT). Bangalore is home to the first smart factory, which was developed in partnership with the Indian Institute of Science (IISc) Bangalore. On the one hand, all IITs and NITs, as well as the top most central institutions, should be encouraged to construct smart factories, while on the other, corporate enterprises should be invited to support the smart factories. Corporate entities that contribute to the development of smart factories will be exempt from paying taxes. Thus, interaction between IITs, universities, and corporate businesses to co-create smart factories would result in information exchange and, as a result, induction and skill upgradation.

4) Smart Operations:
Global manufacturing competitiveness will reflect the sector's degree of smartness in the operations. There is significant improvement in the manufacturing competitiveness score and rank of the country; from 11^{th} rank in 2016 to 5^{th} rank in 2020 (Table 13).

Table 13: Global Manufacturing Competitiveness Index

Global Manufacturing Competitiveness Index rankings	Rank	Score (100 High; 10 Low)
India 2016	11	67.2
India 2020 (Projected)	5	77.5

Source: https://www3.weforum.org

However, when compared to China (ranked first in 2016 and second in 2020), India lags far behind, necessitating more and more smart cost-effective operations in order to achieve a better and the best rank in the Global Manufacturing Competitiveness index and attract more foreign direct investment (FDI) and foreign institutional investors (FIIs). Collaborations with sophisticated economies such as the United States, Germany, Japan, and countries recognised for technological innovation are needed to attain this goal. Furthermore, the government should take steps to prevent brain drain from the nation while also encouraging universities and IITs to do research, encourage them to make application-oriented discoveries, and boost the number of patents for universities and IITs.

5) Smart Products:

Growing demand for high complexity, along with recent technical advancements enabled by industrial transformation, has resulted in the production of more complex and smart products. Producing smart goods necessitates improvements in product development processes, which have seen significant breakthroughs in methods of production in recent years. The fourth industrial revolution will bring the digital and physical worlds together, combining them to better operations and goods. This innovative manufacturing approach provides a chance to increase company productivity and efficiency by utilising smart products that can interface with the industrial environment. The combination of physical and virtual or augmented prototyping enables the low-cost manufacturing of highly adaptable smart goods (Lopes Nunes M, Pereira A C & Alves A.C 2017). This transformation is essential for every industry in the manufacturing sector.

6) Data-driven Services:

Companies that are transitioning from selling items to delivering solutions substantiate data-driven services, which are used to match future business models to improve client advantages. After-sales service is based on data assessment and analysis, with dependence on enterprise-wide integration. Physical items must be outfitted with physical IT in order to send, receive, and process information required for operational processes. The following factors can be used to establish readiness of the company in this area are:

a) Availability of data-driven services – most of the companies are in use of these services. Probably MSMEs we may not see the extensive use of the services.

b) Revenue generated – If the services are available, then question is about the generation of revenue.

c) Data utilisation – how much data is in use and how frequently it is being utilised

CONCLUSION:

Although the literature review reveals a strong need to prepare for "Industry 4.0" implementation, the reality on the ground is extremely different and hard. To achieve strategic change toward manufacturing industry transformation in India, a more systematic approach with participation of all stakeholders, including the government, is required. The IR 4.0 might provide an opportunity for third world economies that have not made large investments in previous industrial technologies.

The Indian Industries can adopt the industry 4.0 readiness model to assess the preparedness of businesses to adopt Industry 4.0 and followed by Industry 5.0.

Each dimension should be given a score, and the percentage score for each dimension should be determined. It will aid in determining the effectiveness with which each of the aspects is applied in organisations. Top management should be made aware of their tasks and obligations in order to ensure the success of their company. According to the model, the organisation should apply Industry 4.0 only when all of the dimensions have a score of more than 75% (Sony, M.& Aithal, P. S. 2020).

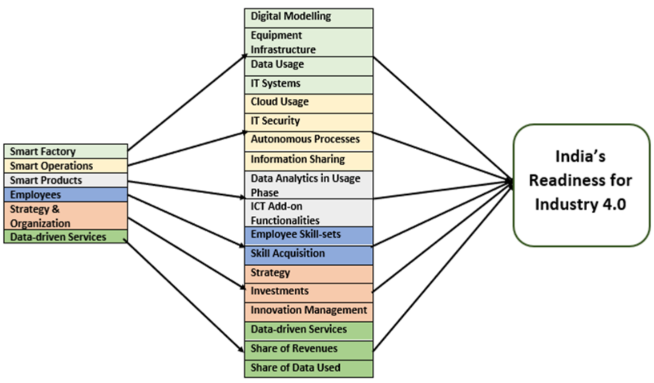

Figure 6: Theoretical Model to Test India's Readiness to Industry 4.0

Source: Author

Indian firms can increase operational profitability by 40% while spending less than 10% of their annual turnover on R&D, according to a McKinsey report. They can do this by using Industry 4.0 across activities such as manufacturing, supply chain, logistics, and procurement (Proschool, 2022).

SCOPE FOR FUTURE RESEARCH:

The following are the research topics for future scope of the study:

i) An Examination of the Indian Cement Industry with Respect to IR 4.0 and 5.0.

ii) Indian Infrastructure sector: An Evaluation with Respect to IR 4.0 and IR 5.0.

iii) Indian MSMEs – Industry 4.0: A SWOT Analysis to Strategize.

iv) The Need for IR 4.0 and 5.0 for the Indian Pharmaceutical Industry.

v) Analytical Study of the Education Sector with Respect to IR 4.0 and 5.0.

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